

The Destructive Diplosis of the Monterey Pine.

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PREFATORY NOTE—While the late W. A. SNOW was engaged as assistant and instructor in entomology at Stanford University, he discovered and began the careful study of a new species of *Diplosis* which was vigorously attacking the Monterey Pines growing on the campus and in the neighborhood of the University. The Monterey Pine (*Pinus radiata* Don. and the Monterey Cypress (*Cupressus macrocarpa* Hartw.) are the conifers most abundantly used as ornamental trees in the grounds and parks of the residents of the San Francisco peninsula. The new *Diplosis* is the most formidable pest which the Monterey Pine has to struggle against, and it is still a question, despite the beneficial activity of certain parasites of the midge, whether the pest may not succeed in killing many of the splendid trees of the region. The pest is extremely abundant, thousands of trees being attacked, and most of the infested trees harboring myriads of the insects.

Mr. SNOW began his observations in November, 1897, and continued them until March, 1899. Since that time Miss Helen Mills, student in the department, has continued the study of the pest. Mr. SNOW's long-continued careful observation and study of the insect, resulted in the nearly complete working out of its extremely interesting life history. With characteristic thoroughness Mr. SNOW extended his work to include a valuable compilation of facts regarding the already known pine midges of this country and Europe. He also interested a botanist, Mr. Cannon, assistant in the University, in the character of the deformation of the plant tissue, and a careful study was made by Mr. Cannon of the pathologic phenomena in the growing buds and needles due to the presence of the irritating and food taking pest (an account published elsewhere). Mr. SNOW's sad death (by drowning in San Francisco Bay, Oct. 10, 1899) leaves unpublished any reference at all to this last undertaking in his career as a student of entomology. In fairness to his memory and in fair-

ness to entomologists there should be published some adequate account of this last investigation. But the editing of the mass of notes at hand is a task I am, at present, unable to undertake. The best I can do is to offer this briefest abstract of the life history of the new pest together with a description of it, revised by Dr. S. W. Williston. In making this abstract Miss Mill's notes have been also referred to, and the drawings were made by her.—VERNON L. KELLOGG.

In the fall of 1896 certain of the Monterey Pines (*Pinus radiata* Don.) on the campus at Stanford were noticed to have their needles shortened and swollen at the base. The injury appeared to be such as might have come about through a sudden retarding of the growth of the needles. In the Autumn of 1897 the injury to the pines was widespread and very noticeable. Examination of the stunted and swollen needles revealed Cecidomid larvæ lying at the bases of these needles, and the injury was definitely traced to them. The first adults were obtained in the laboratory Jan. 12, 1898, from affected branches brought to the laboratory a month before. The adults were found to be an undescribed species of *Diplosis* related to the already known half dozen species of *Diplosis* known to attack the pine trees of Europe and America.

The eggs (fig. 1, e) are smooth and elliptical, and light yellow in color changing to orange-yellow as the embryo develops within. The female moves about over a terminal bud attempting at intervals to thrust her long flexible ovipositor in between the scales. When successful she deposits from 2 to 24 eggs in mass. The ovipositor is sometimes bent like a bow by the efforts of the insect to force apart the scales of the buds. Not infrequently females would be found caught and held by the pressure of the scales on the ovipositor. The egg stage is about two weeks. The female dies soon after oviposition.

The larvæ (fig. 1, l) immediately after issuing from the eggs make their way into the basal part of the bud and remain in there. The body is broadly elliptical and reddish yellow in color and when full grown is from 1 mm. to 1.5 mm. long. The breastbone (fig. 1, b, b), well chitinized in the older

stages, is not visible in newly-hatched specimens. None of the abdominal segments bear nipple-like spiracles. The skin is covered with fine spinules. When ready to pupate the larva usually spins a thin oval cocoon. Sometimes it does not. The larvæ pupate within the deformed buds. The duration of the larval stage is ten or eleven months.

The pupæ (fig. 1, p) are of the same general color as the larvæ, the thoracic region of the body being darker. The body is covered with cuticular spinules as in the larva. The breathing-tubes are non-segmented and are slightly folded over at the top. The duration of the pupal stage is three or four weeks.

Adult.

Diplosis pini-radiatæ n. sp.

Male (fig. 2).—Antennæ slender, a little shorter than the body, yellow or brownish yellow, the basal and terminal joint darker; basal joint large; second joint smaller, more globular, sessile; remainder of antennæ with twenty-four spheroidal dilatations, the terminal one more conical, and with a suture separating the minute terminal joint; petioles slender, about as long as the dilatations proximally, proportionally a little longer distally; the swellings decrease in size uniformly and gently, each with a verticil of black hair and a circle of shorter, yellowish looped filaments more distally. Head deep brown or black. Mesonotum dark reddish brown or blackish, somewhat whitish pruinose, and with three rows of dusky hairs. Pleuræ above, and the scutellum reddish. Abdomen obscurely reddish brown or black, with rather long, blackish hairs. Legs yellow or yellowish, with close-lying, for the most part, black hairs, and longer, chiefly white hairs, especially upon the tibiæ and tarsi; tip of tibiæ and tarsi usually brownish. Wings greyish hyaline, with blackish hairs along the costa, and a fringe of longer dark hairs along the posterior margin. The first vein terminates near the middle, the third at the extreme tip of the wing, the latter strongly convex; origin of third vein indistinct; wings rather slender.

Female (fig. 3).—Basal joints of antennæ as in the male, the twelve dilatations are more elongate cylindrical, the petioles much shorter; the dilatations are more slender distally and show here slight constrictions. Mesonotum usually less deeply colored, the upper part of the pleuræ and the scutellum yellow or yellowish. Abdomen red, the basal segments above obscurely marked with brown or black hair, loose, abundant and long; ovipositor usually protruding about as far as the length of the body.

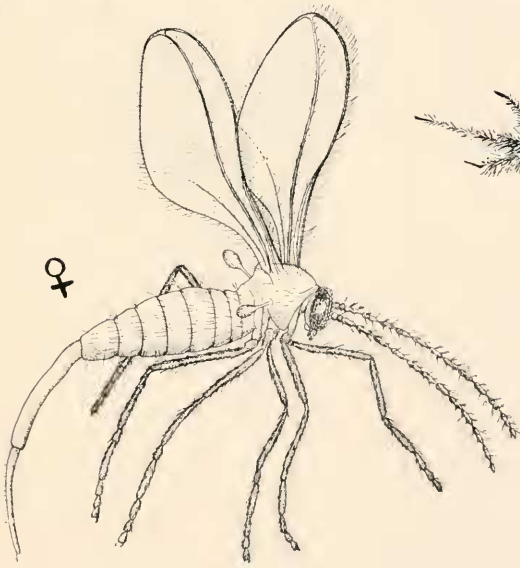
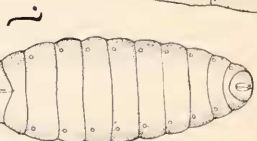
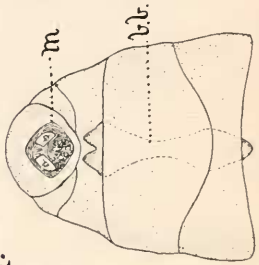
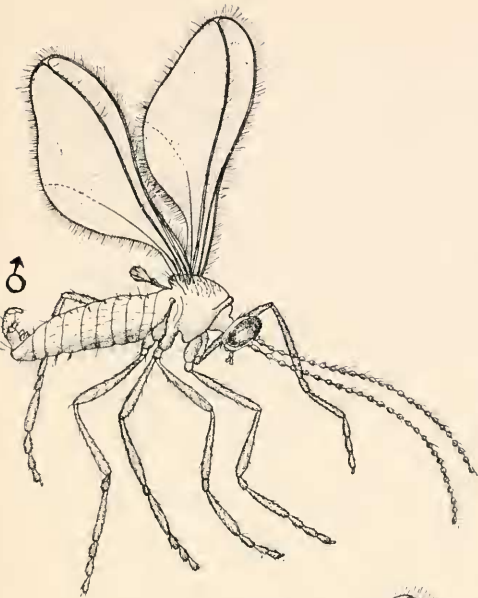
Five males and five females, No. 232, Leland Stanford University, June, 1899.

There seems to be but one generation a year. Adults begin to issue about the middle of January and continue to appear until the first of March. Egg-laying proceeds all through this time, and old larvæ and pupæ may also be found all through this period (no larvæ towards the end of the period). The eggs hatch in about two weeks and these larvæ lie in the bases of the fascicles of needles all through the Summer and Autumn and early Winter not pupating until December. The adults issue in a few weeks and the life cycle is begun.

The character and extent of the injury caused by the insect make of it a serious pest. The number of larvæ lying in the bases of the fascicles is sufficient to completely stunt and deform all the needles of the fascicle. On a single tree three-fourths of the fascicles may be thus injured. This practical denudation of the tree may be repeated several times. It is simply a matter of how many such denudations the tree can withstand. Plate XII, made from a photograph of an unattacked branch and a seriously attacked branch, shows better than words can explain the effective character of the pest's injuries.

Fortunately several natural enemies of the pest are at work, and in many places have done much to dissipate the threatened danger. *Polygonotus diplosidis*, previously found as a parasite of *Diplosis pini-inopis* O. S. (scrub-pine in New Jersey), and a mite very like *Pediculoides ventricosus* (referred to by Marlatt as an efficient agent in the destruction of the eggs of *Cicada*), are both doing good work. The mite feeds on eggs, larvæ and pupæ indiscriminately. It attaches itself by its mouth-parts and forelegs to a larva and clings to it until the death of the larva. The usual predaceous insects, such as the larvæ of *Hemerobius* and *Chrysopa*, the larvæ and adults of several Coccinellids and the nymphs of certain Reduviidæ are all to be found on the pines and probably help in fighting the pest. The Ruby-crowned Kinglet has been observed to eat many of the midges. The birds pick off the females while they are on the buds ovipositing.

The pest is not confined to the Monterey Pine (*Pinus radiata*), but has been taken from the following species of *Pinus*: *tuber-*



D, FLORIS PINI RADIATÆ. E, EGGS. L, LARVA. BB, BREST-BONE. M, LARVAL MOUTH-PARTS. P, PUPA. A, MONTEREY PINE, NORMAL. B, MONTEREY PINE, INJURED.

